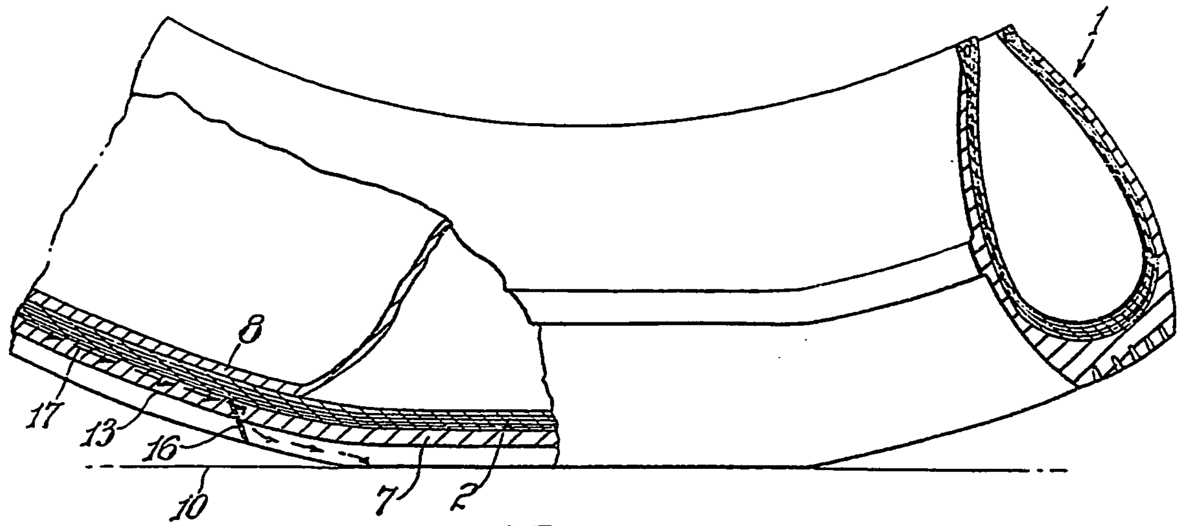

Fig. 2.

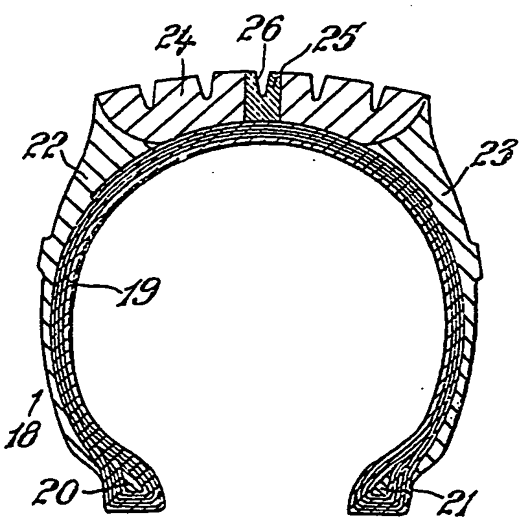

Fig. 3.

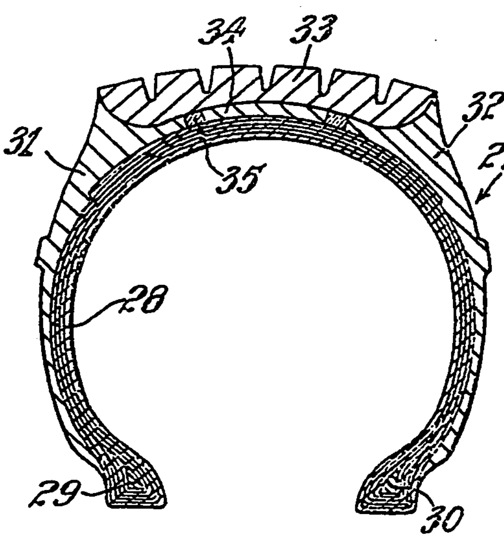

Fig. 4.

544,757 COMPLETE SPECIFICATION

SHEET 1

2 SHEETS
SHEET 2

[This Drawing is a reproduction of the Original on a reduced scale.]

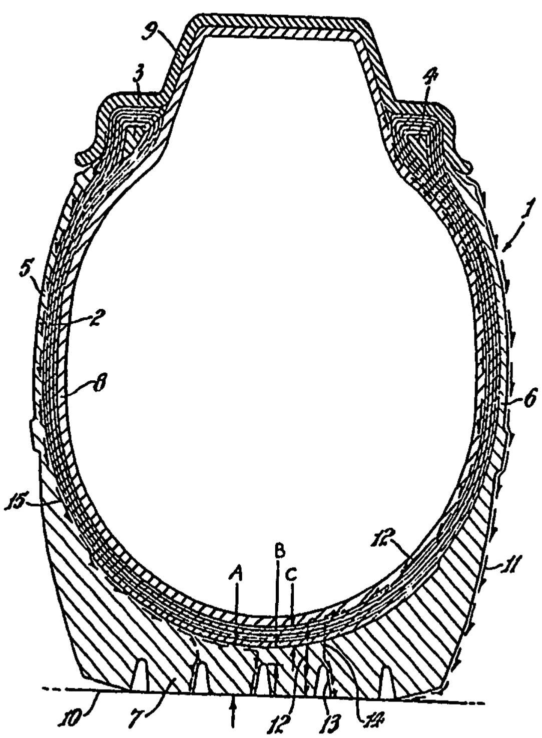

Fig.1.

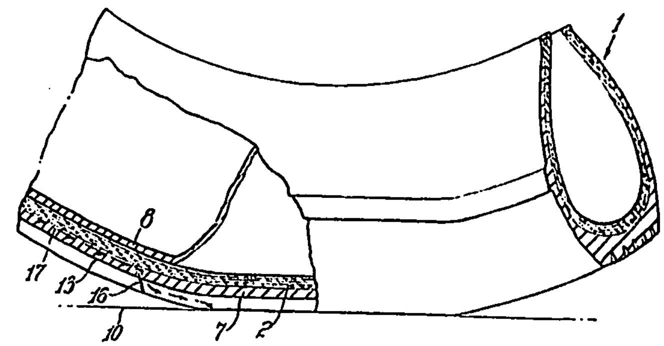

Fig.2.

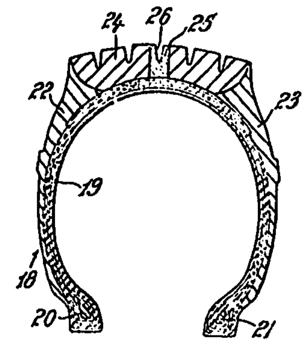

Fig.3.

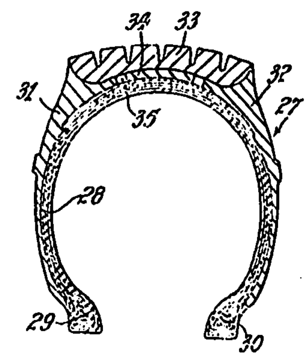

Fig.4.

Malby & Sons, Photo-Litho

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PATENT SPECIFICATION

Convention Date (United States of America): Feb. 15, 1940. **544,757**

Application Date (in United Kingdom): Feb. 3, 1941. No. 1375/41.

Complete Specification Accepted: April 27, 1942.

COMPLETE SPECIFICATION

Improvements in a Pneumatic Tyre and method of making same

We, UNITED STATES RUBBER COMPANY, a corporation organized and existing under the laws of the State of New Jersey, United States of America, having our registered office at Rockefeller Center, 1230, Sixth Avenue, New York, United States of America, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

This invention relates to pneumatic tyres and, in particular, it relates to pneumatic tyres embodying features of electrical conductivity. More particularly, this invention relates to pneumatic tyres having an electrically conducting path extending substantially from the bead region of the tyre to the road contacting surface of the thread.

Rubber compositions are generally considered as insulating materials; however, for certain purposes, it is highly desirable to provide a composition which retains all of the advantageous flexing and wearing qualities of rubber and includes the additional characteristic of being electrically conducting.

A specific example of the use of an electrically conducting rubber composition is the pneumatic tyre. It is well recognized that vehicles such as automobiles and airplanes accumulate static electricity. In certain cases this accumulation of electricity becomes objectionable and has a definite detrimental effect on the tyre assembly. The amount of static electricity generated and accumulated in different vehicles varies considerably. It is known, however, that the static electricity accumulated on an automobile in relation to the ground gives rise to voltages frequently in excess of 10,000 volts. As a vehicle thus charged comes to a stop, a person outside of the car and who touches the car, can suffer considerable discomfort as the accumulated static electricity is discharged to the body. While such a condition is usually not dangerous, it constitutes a nuisance and is the cause of many complaints.

Another objectionable feature of the accumulation and periodic discharge of static electricity within or on an automobile is the disturbance it produces in car radio reception. The scope of radio performance is also improved by providing a vehicle with tyres having the desired electrically conducting characteristics.

Another benefit resulting from the use of tyres having electrically conducting characteristics is a decrease in cracking and consequent failure of inner tubes. It appears that in conventional tyre assemblies static electricity is frequently discharged by following broken paths formed of impurities lying between the tyre carcass and the inner tube. A discharge of static electricity produces ozone, and in the proximity of rubber compositions, ozone has a detrimental effect on the life of rubber, particularly when the compositions are under tension stresses.

It is recognized that a tyre formed of rubber composition containing proper proportions of acetylene carbon black provides a rubber composition which has desirable conducting characteristics for discharging static electricity. However, a rubber composition which contains a sufficient quantity of acetylene carbon black to render it effective for discharging static electricity, loses many of its desirable characteristics, such as, resistance to abrasion and cracking.

In order to preserve the good qualities of a rubber composition and, at the same time, incorporate the electrically conducting feature, we have found that an electrically conducting rubber cement, as herein defined, when applied to specific portions of a pneumatic tyre, will function effectively in discharging static electricity. It is, therefore, among the objects of our invention, to provide a pneumatic tyre having electrically conducting characteristics without impairing the advantageous qualities of the rubber composition; to provide a tyre which substantially eleminates static shock; to provide a tyre which is beneficial to automobile radio performance; to provide a tyre which substantially eliminates the hazard of sparks; to provide a tyre which substantially reduces the generation of

[Price 1/-]

ozone in the region of the tyre assembly and consequently prevents premature failure of the tyre or tube; and to provide a tyre having increased electrical conductivity and which may be manufactured efficiently and economically. These and other objects and advantages will appear more fully from the following detailed description when considered in connection with the accompanying drawings, in which:—

Figure 1 is a transverse view in section, of a tyre assembly embodying features of our invention;

Figure 2 is a portion of a side elevational view of a tyre partly in section, illustrating the circumferential path of conductivity; and

Figures 3 and 4 are transverse views, in section, of pneumatic tyres, illustrating modified forms of the invention.

Referring to the drawings, and, in particular, to Figure 1, an embodiment of the invention is shown in the form of a pneumatic tyre 1 comprising essentially a carcass 2 formed of plies of strain resisting elements, bead wires 3 and 4, sidewall portions 5 and 6, and a tread portion 7. The tyre, as illustrated, is shown in assembly form and includes an inner tube 8 and a rim 9. A line 10 represents the road or other supporting means which contacts with the tyre tread.

The principal purpose of the present invention is to provide an electrically conducting pathway extending from the rim 9 to the ground 10. The tread and sidewall portions of the pneumatic tyre being formed of a rubber composition provide a material which is generally considered as an insulator or non-conductor. The carcass of the tyre is also considered an insulator, it being formed principally of a rubber composition in combination with cotton or rayon cords. It is recognized that the sidewall portions 5 and 6 and the tread portion 7 may be formed of a rubber composition containing relatively high percentages of a conducting material, such as acetylene carbon black; however, the resulting composition of such a combination is not suitable for tyre purposes because of the lower abrasion resistance of the composition and because of its susceptibility to cracking.

In the practice of the present invention it has been found that a rubber cement containing a relatively high per cent. of acetylene carbon black produces a composition, when dry or vulcanized, which by far exceeds the conductivity characteristics of conventionally compounded rubber compositions. The use of an electrically conducting rubber cement, therefore, has the advantage of presenting a higher degree of conductivity, while at the same time permitting the customary rubber compositions to be used for the sidewall and tread portions of a tyre, which portions thus formed are more suitable for obtaining maximum performance in pneumatic tyres.

In conventional tyres the electrical resistance from the tyre rim to the ground frequently exceeds 100 thousand megohms. Such a tyre embodies a rubber composition having an electrical resistivity in the order of one thousand megohm centimeters. This resistance is generally considered too high for an adequate discharge of static electricity. The invention, therefore, contemplates a reduction in the resistance of the tyre from the tyre rim to the ground to one thousand megohms or less or to a rubber composition resistivity of 0.1 megohm centimetres or less.

It has been found that a layer of rubber cement two or three thousandths inch in thickness, and having a high degree of electrical conductivity may be applied prior to vulcanization to the outside of a tyre casing, and will form a conducting path, such as indicated by the directional arrows 11, extending from the tyre rim to the ground. Such a path provides an adequate means for discharging static electricity. An example of a cement suitable for this purpose is as follows: (the parts are by weight):

Rubber	-	100 parts
Acetylene Black	-	60 ,,
Stearic Acid	-	6 ,,
Pine Tar	-	4 ,,
Zinc Oxide	-	4 ,,
Accelerator	-	1 ,,
Sulphur	-	3 ,,

These materials are milled together and subsequently dissolved in a suitable solvent such as gasoline or benzene to form a cement of a liquid consistency. The conducting path thus formed from the tyre rim to the ground and embodying a cement substantially as above described, provides a total resistance in the order of 0.1 to 100 megohms.

While reference is made to acetylene black as providing the principal electrically conducting element in the cement composition, it is to be understood that we contemplate other carbon blacks having conducting characteristics within the range herein disclosed, and that reference to conducting cement or conducting carbon black is intended to include those carbon blacks which possess sufficient conductivity to permit the construction of a tyre having an electrical resistance within limitations specified. While the above table specifies 60 parts of acetylene black,

the invention contemplates a proportion of acetylene black of at least 15% by weight of the cement solids.

The use of a rubber cement on the outside of a tyre casing is sometimes objectionable because of the probability of its wearing off, particularly at the sidewall portions of the tyre. We have, however, found that a coating of cement may be applied to the inner wall of a tyre casing to form a conducting path leading from the tyre rim to a point spaced from the ground by the combined thickness of the tread and carcass wall. Such a conducting path is illustrated in Figure 1 by the directional arrows 12. The coating of conducting cement is applied to the tyre prior to vulcanization, so that in the finished product the conducting rubber cement forms a film or layer which becomes an integral part of the tyre.

While both the tread and carcass portions have poor conducting characteristics, the use of a conducting cement on the inner wall of the carcass presents a conducting path to a point relatively close to the ground. Thus the tyre tread may still retain good abrasion resistance and may retain a relatively low conductivity. Nevertheless, the short distance remaining for the electricity to discharge to the ground provides a tyre combination considered to have satisfactory characteristics for discharging static electricity. If desired, the walls 13 which form grooves to provide anti-skid elements on the tread 7 may be coated with a layer of conducting cement and, as shown by the arrows 14, the distance between the ground 10 and the inner wall of the carcass may be shortened considerably, thus resulting in a better discharge of static electricity.

In a 6.00-16 tyre provided with conducting cement between the carcass and the sidewalls and tread, as indicated by arrows 15, the electrical resistance from rim to ground is in the order of 100 megohms. If the walls 13 of the tread grooves are coated with a conducting cement, the path of conductivity may be shortened, as indicated at B, so that the total resistance under such a condition is approximately 20 megohms. Where the conducting cement is applied to the inner wall of the tyre casing, the static discharge must also pass through the carcass wall, as indicated by the thickness C. This represents an additional resistance in the order of 1,000 megohms. Thus, where the conducting cement is applied to the inner wall of the tyre casing, the total resistance from the tyre rim to the ground is of the order of 1,100 megohms, a resistance being within the limitations generally considered to provide a pneumatic tyre having satisfactory static conducting characteristics. If desired, both the inner wall of the carcass and the outer wall of the tyre casing may be coated with the conducting cement, with the result that two paths are formed, as indicated by the directional arrows 11 and 12. This combination increases the conductivity of the tyre assembly.

In certain cases it may be found desirable to apply the conducting rubber cement to any one of the plies which forms the tyre carcass 2. Still further, the conducting cement may be applied in paths or in the form of strips or bands. In other words, it is not particularly essential to coat the entire surface of any tyre component in order to obtain the benefit of low resistance.

Treads, including the sidewall portions, as manufactured for pneumatic tyres, are usually in strip form and the ends are thereafter spliced together to form an annular band. To form a splice, the ends of the tread are skived and a rubber cement is applied to the skived ends to increase the union of the splice. It has been found that if the rubber cement used at the skived ends of the splice is in the form of a conducting carbon black cement, an electrically conducting path is formed from the inner to the outer surfaces of the tread.

The tyre as shown in Figure 2 illustrates a tread splice 16 and indicates that a conducting path, as shown by the arrows 17, forms a conducting line extending from the inner surface of the tread to the outer surface thereof. If the outer surface of the tread is also painted with a layer of conducting cement, with particular reference to a covering layer on the walls of the tread grooves 13, the conducting path will extend along the inner surface of the tread 7, through the tread splice 16, and along the walls of the tread grooves 13, until it reaches the ground 10.

By applying the conducting cement to the tread splice, no extra operation is required, and, consequently, no substantial increase in the cost of the tyre results. By providing a conducting cement on both inner and outer surfaces of the tread and also at the tread splice, a total electrical resistance from the tyre rim to the ground of approximately 0.5 megohms is obtained.

An important advantage obtained by following the practice as herein outlined is a reduction in inner tube cracking and consequent premature tyre failure. In mounting tyre and tube assemblies on tyre rims, particularly for production requirements, it is customary to apply a soap solution to the bead portions of the tyre as a lubricant to assist in the mounting

operation. Frequently an excess of such material is used, so that it accidentally spills into the casing or between the casing and the tube. Materials such as these operate as partial conducting paths, and as such material is susceptible of cracking and separating, the conducting paths are broken. A result of this condition is that static electricity is discharged from one particle to another, causng a formation of sparks along the inner surface of the tyre carcass and between the tyre carcass and the inner tube. Laboratory tests have demonstrated that cracking and failure of inner tubes have frequently been caused by the formation of ozone at those regions of the inner tube where static sparks occur along the inner wall of the tyre casing. The use of conducting cement for forming an adequate path for discharging static electricity overcomes the objectionable result of static sparks and prevents inner tube cracking and consequent premature failure of the tyre assembly.

Figures 3 and 4 illustrate further modifications of the invention. Figure 3 shows a pneumatic tyre 18 comprising a carcass 19 formed of plies of strain resisting elements, bead wires 20 and 21, sidewall portions 22 and 23, and a tread 24. It is sometimes customary to form the sidewall portions of a pneumatic tyre of a different rubber composition than the tread portion. This is preferable because of the different service conditions to which the particular portions of rubber composition are subjected. In certain cases the sidewall portions 22 and 23 may be formed of a rubber composition which includes a relatively high percentage of conducting carbon black. In such cases the rubber composition forming the sidewalls provides a conducting path leading from the tyre rim to the tyre tread. This considerably shortens the thickness of relatively non-conducting material between the tyre rim and ground, thus making it possible to utilize a tread having a relatively high electrical resistance. By employing such a construction, a tyre may be formed having a resistance from rim to ground of approximately 1000 megohms.

In the case of white sidewall tyres, the white rubber composition is characterized by its high resistance, therefore, it is preferable to employ the conducting rubber cement underneath the tread and sidewall portions and adjacent to the carcass; or as described hereinabove, the conducting cement may be applied to any component of the carcass.

Where cement is used underneath the tread and sidewall portions, a still greater advantage in conductivity may be obtained by forming one or more transverse slits 25 radially through the tread 24 and injecting a conducting cement into the slit thus formed. Such a slit may be made into the tread prior to vulcanization of the tyre, and, consequently, its presence remains unnoticeable and does not affect the functional characteristics of the tyre. The slit 25 is preferably formed through the tread at a location where it intersects one or more of the circumferentially extending grooves 26 formed in the tread 24. The walls of these grooves may be coated with a conducting cement, thus forming a continuous path for the discharge of static electricity from the tyre beads to the road engaging surface.

Slits as represented by the numeral 25 and containing a conducting cement may be employed for forming a conducting path through the tread of the tyre illustrated in Figure 1. Such a slit or slits may be substituted for the tread splice conducting path as shown in Figure 2, or the slits may be used supplementary to the tread splice conducting path.

In the manufacture of pneumatic tyres, it is sometimes found desirable to form a two-piece tread, that is, a tread in which both sidewalls are interconnected and formed of the same rubber composition, but including a tread portion of a different rubber composition. Such an example is illustrated in Figure 4 in which is shown a pneumatic tyre 27, including a carcass 28, bead wires 29 and 30, sidewall portions 31 and 32, and a tread portion 33. The sidewall portions 31 and 32 are joined together at the crown portion of the tyre to form, in effect, a subtread 34. As hereinbefore stated, it is sometimes preferable to provide a tyre having sidewalls of rubber composition having a high electrical resistance. Because of the subtread 34 the carcass of the tyre is effectively insulated from the tread 33. In order to overcome this condition and to facilitate a conducting path from the tread 33 to a layer of conducting cement lying between the subtread and the tyre carcass and the sidewalls 31 and 32 and the carcass 28, we provide one or more slits or openings 35 extending through the subtread 34. These slits or openings which may extend in any direction, are coated or filled with a conducting cement, thus forming a conducting path from the tread 33 to the conducting cement underlying the subtread 34.

The conducting characteristics of the tread 33 may be higher than those of the sidewall portions 31 and 32, and by this method a conducting path is formed, in which the resistance from the tyre rim to the ground is within the range considered as a satisfactory conducting tyre. Even though the tread 33 provides a high

resistance, the relatively short distance of travel required for the discharge of static electricity to the ground results in the formation of a satisfactory static discharging tyre.

While reference is made to an electrically conducting cement, it is obvious that a thin layer of milled rubber composition may be substituted in place of the cement. An example of a milled rubber composition is as follows (parts by weight):

Rubber	100	parts
Acetylene Black	50	,,
Stearic Acid	5	,,
Pine Tar	4	,,
Accelerator	1.15	,,
Antioxidant	1.35	,,
Zinc Oxide	4	,,
Sulphur	3	,,

It is to be understood that reference to a conducting cement or conducting rubber composition is intended to include a range of conductivity suitable for the discharge of static electricity. Such a range is within the limitations up to approximately 0.1 megohm-centimeters.

Reference to the electrical conductivity or resistance of conducting cements as herein defined is intended to refer to the conducting cement in the form of a dried film or in the form of a vulcanized layer originating from the application of a coating of cement.

From the foregoing description, it is believed apparent that we have provided a novel and unique tyre and method in which static electricity may be effectively discharged from vehicles, and which results in substantial elimination of static shock, improvement in car radio performance, prevention of premature failure of a tyre assembly, in combination with an efficient and economical method of manufacture.

While we have thus shown and described preferred embodiments of our invention, it is to be understood that it is susceptible of other modifications, all of which we contemplate as appearing within the scope of the appended claims:

Having now particularly described and ascertained the nature of our said invention, and in what manner the same is to be performed, we declare that what we claim is:—

1. A peumatic tyre characterized by a layer of electrically conducting vulcanized rubber composition forming a conducting path over a substantial portion radially of the tyre.

2. A pneumatic tyre according to claim 1, wherein the electrically conducting rubber composition is a rubber cement containing carbon black.

3. A pneumatic tyre according to claim 1, wherein the layer of electrically conducting rubber composition extends from the bead regions of the tyre to the tread.

4. A pneumatic tyre according to claim 2, wherein the electrically conducting rubber cement is on the outer surface of the side wall portions of the tyre.

5. A pneumatic tyre according to claim 2, wherein a coating of electrically conducting rubber cement lies adjacent the inner wall of the carcass of the tyre.

6. A pneumatic tyre according to claim 5, wherein a coating of electrically conducting rubber cement is also interposed between the carcass and the sidewall portions of the tyre.

7. A pneumatic tyre according to claim 2, characterized by the fact that when the tyre tread has an antiskid pattern including grooves a coating of electrically conducting rubber cement is applied to the tread including the walls of the tread grooves.

8. A pneumatic tyre according to claims 5 and 6 characterized by an electrically conducting rubber cement forming a path joining said inner and outer coatings of conducting rubber cement.

9. A pneumatic tyre according to claim 8 wherein the path joining said inner and outer coatings of conducting rubber is formed by electrically conducting rubber composition at the tread splice.

10. A pneumatic tyre according to claim 1, wherein the major part of the side walls is formed of a rubber composition having an electrical resistivity equal to at least about 1,000 megohms centimetres while a rubber composition having an electrical resistivity equal to not more than about 0.1 megohm-centimetres forms a part of the tyre in a path extending from the bead regions of the tyre to the road contacting surface of the tread.

11. A pneumatic tyre comprising a carcass of strain resisting elements, a tread portion of rubber composition, sidewall portions of rubber composition, and a coating of rubber cement interposed between the carcass and the sidewall and tread portions, said cement containing at least 15% by weight of the cement solids of acetylene carbon black.

12. The method of forming an electrically conducting tyre comprising applying a layer of electrically conducting rubber cement to the inner wall of a tyre casing and vulcanizing the tyre.

Dated this 31st day of January, 1941.

T. A. CLAYTON,
Acting for Applicants.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1942.

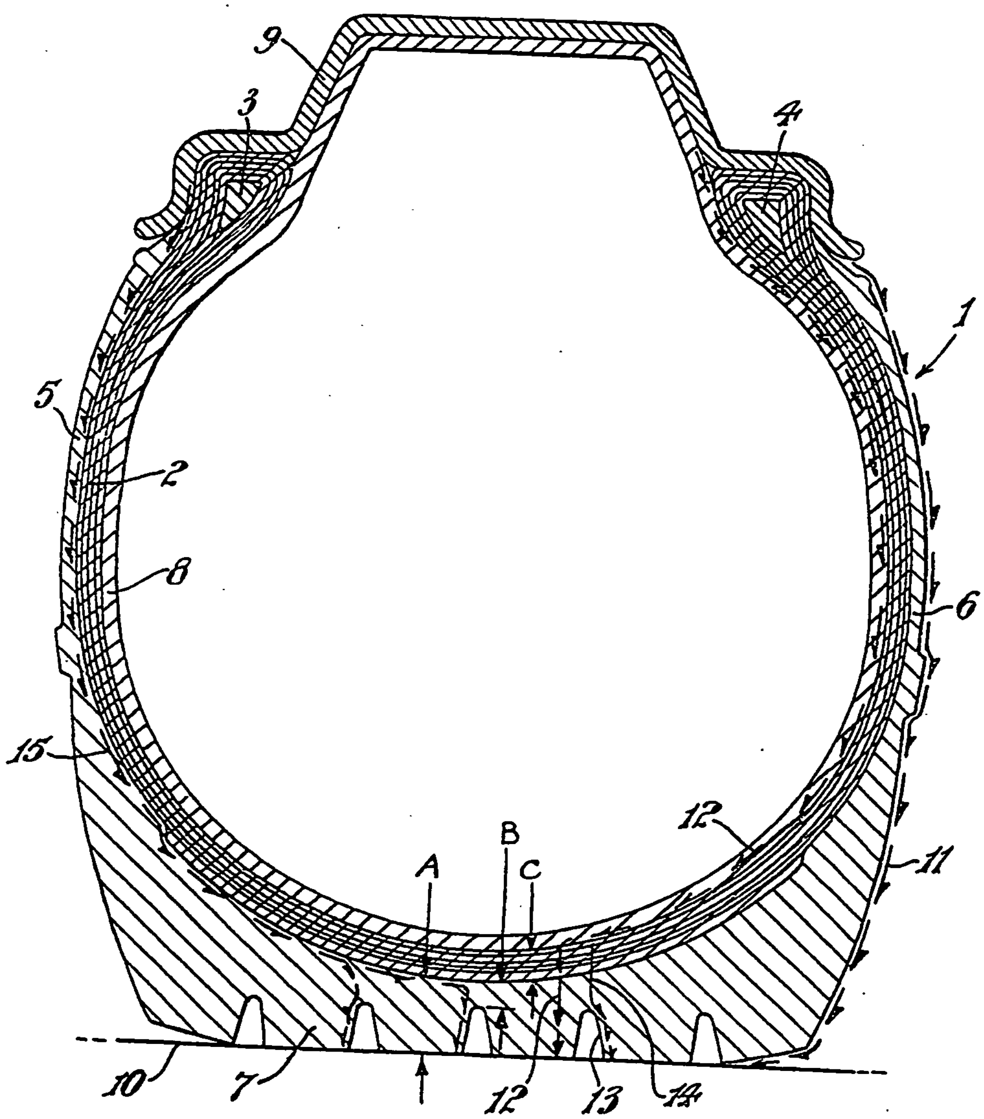

Fig.1.